Outline of Proposed Research Work

# "Spatio-Temporal Analysis of Rainfall Variability on Sahyadri in Maharashtra"

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**Swami Ramanand Teerth Marathwada University, Nanded**

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## 1. INTRODUCTION

The climatic phenomenon affects every human activity. Temperature, precipitation, humidity, air pressure, wind, evapotranspiration, cloudiness etc. affect the distribution of biotic and abiotic elements over the earth surface. The temperature and rainfall are the major controlling factors of social and economic development of any country. In India, monsoon rainfall is a principal source of water. The country received more than 80 percent rainfall from south west monsoon. Spatio-temporal variability of rainfall in the sub-division of country is creating problems of flood and drought and it creates problems in front of the government.

Agriculture is the principal occupation of country. In India, more than 60 percent peoples are depending on agriculture sector for the livelihood. Agriculture growth depends on the monsoon rainfall; however it is called as a gamble of monsoon. The crop calendar of Kharif and Rabi season depends on south west monsoon. Uncertainty of monsoon rainfall influences the agriculture production. According to the **Pranab Mukharjee (**President of India**),** “Monsoon is the real finance minister of India”. Many researchers and scientist are investigating the variability of rainfall, tread of rainfall, active and break period of monsoon, wet and dry situation, relationship between agriculture and monsoon in the country.

Indian monsoon systems are split into two branches by the triangular shape of Indian peninsula, one branch blowing from Bay of Bengal and another from Arabian sea. Bay of Bengal branch received rainfall at Andaman and Nikobar island and seven sister states of Indian country. Arabian sea branch received rainfall at western, central, northern and north-west regions in the country.

## 2. REVIEW OF LITERATURE:

Review of literature is the integral part of every research process. It is useful for understanding about the previous research work and research gap. The past research work and research gap gives perfect path to the researcher for choose the research problem. Several researches have been done related to rainfall in India and different parts of the world.

Barkade, A.J. and Sule, B.M. (2011), studied the rainfall variability in Solapur district of Maharashtra. Lal, D.S. (2011), gives the detailed information about the different climatic

phenomenon and various methods for weather analysis and forecasting, in his book entitled "Climatology". Dr. Soybam, H. S. (1990), studied rainfall characteristics of Pune district. Dr. Ingale, S.R. (1995), studied the various rainfall characteristics of Goa state.

G.Plous Michael (2012), studied rainfall, crop rainy days and soil temperature of Western ghat states. In this study they analyzed ARIMA forecasting, modified drought index, crop rainy days, durnial variation of soil temperature and its effect on rainfall. They investigate 30 years annual mean of rainfall and drought analysis. Mohapatra and Mohanty (2006), studied the variability of monsoon rainfall over Orissa in the relation to low pressure belt.

Gore, P.G., Thakur Prasad and Hatwar, H.R. (2010), published an article on mapping of drought areas over India. In this they focused on the probabilities of drought and founded the moderate drought probability all over the India.

Guhathakurta, P. and Rajeevan, M. (2006), studied the rainfall of 1476 raingauge stations in India. In this study they investigated the trends of Annual and Seasonal rainfall of Indian Sub-division. They found out that the contribution of July rainfall is decreasing and August rainfall is increasing over central and western peninsula of India and increasing. Decresing trend of rainfall is shows over the Jharkhand, Chattisgarh, Kerala and increasing trend shows over west Uttar Pradesh, West Bengal, Jammu and Kashmir, Konkan and Goa, Royalseema, costal Andra Pradesh, central Maharashtra and north interior Karnataka.

Karande, S.V. (2016), studied about the spatio-temporal climatic characteristics of Satara district. In this research, they found that the climatic conditions of Satara district change as per longitudinal direction. Kiran Prakash, K. (2011), studied the prediction and estimation of rainfall using various statistical approaches.

Minder, J.R. (2010), studied the climatology of orographic precipitation in the mid-latitudes. Nair, V.G. (2006), studied impact of western ghats orography on the weather and climate over southern peninsular of India. Robert A. Houze Jr (2011), studied the orographic effects on precipitating clouds. Roe, G.H. (2005), published an article on the influence of surface orography on patterns of precipitation of world.

Patil, B.D. (2015), studied characteristics of rainfall of the west Khandesh region of Maharashtra state. Patil, M.K. (2015), studied the change in the seasonality index of rainfall in Sangli district of Maharashtra.

Pradeep Kumar, P.K. (1994), studied about the physiographic features such as orography, longitude, latitude, altitude, vegetation cover and its impact over the rainfall pattern of Kerala. They found that the effect of orography, mountain barriers and hilly terrain

over the rainfall of Kerala. They concluded that the maximum rainfall is not at the top of hill or mountain but at the windward side of mountain.

Shah Shital (2013), studied the Modeling of Rainfall Variability and Drought assessment in Sabarmati basin using a various method and techniques. In this study, they found that the similar rainfall trends in the various stations and large temporal variability between years in the Sabarmati basin of Gujarat. Subrahmanayam V.P. (1983), has studied applied climatology of the Indian region and published sixteen articles. They kept view in the present developments and trends in Indian climatology.

## 3. STUDY AREA

Western ghat and Eastern ghat are major ranges in the Indian peninsula. Western ghat travels from north to south direction parallel to Arabian Sea. Whereas, Eastern ghat is parallel to the Bay of Bengal. Western ghat lies between Satpuda range in north to Nilgiri hills in south. The length of Western ghat is 1600 km. and it covers in the Maharashtra, Goa, Karnataka, Tamil Nadu and Kerala states. It is one of the reach biodiversity place in the world and UNISCO declared some places of western ghat as a world heritage site. In Maharashtra, western ghat is called Sahyadri.

The Sahyadri is located in the western side of Maharashtra. The geographical location of the Sahyadri is $15^0$37' to $20^0$15' north latitude and $73^0$14' to $74^0$17' east longitude. Kalsubai (1646 m.) is the highest point in the Maharashtra. The length of Sahyadri in Maharashtra is 520 km. from north to south and average width is 55 Km. from east to west. The Sahydri is distributed into ten districts of Maharashtra, i.e. Nasik, Ahmednagar, Thane, Pune, Raigarh, Satara, Ratnagiri, Sangli, Kolhapur and Sindhudurg. Sahyadri is the main water-parting of east and west flowing river of Maharashtra. Krishna, Godavari, Vaitarna, Savitri, Koyana, Warna, Bhima, Vashisthi, Kukadi, Nira etc. are major river origin on Sahyadri. It is a transitional zone between the tropical humid and semi-arid climatic zone of western Maharashtra and Konkan.

The average mean temperature of Sahyadri is $24^0$C. The western side of Sahyadri received more than 5000 mm rainfall and the leeward side of Sahyadri received less than 2000 mm rainfall. The physiography of Sahyadri brings about spatial variability of rainfall distribution. The spatial distribution of rainfall is rapidly decreased towards eastward direction in few Kilometers belt over high range of Sahyadri mountain. Sahyadri has very reach in flora and fauna. Many extinct and endangers species of the world are found in the

Sahyadri. The Kas plateau is involved in the world heritage site by UNISCO. In Maharashtra, very limited and systematic studies are done on climatic characteristics. However there are more scope for the investigation of rainfall variability.

## 4. OBJECTIVES OF THE STUDY

The main objective of this study is to investigate the spatial distribution of rainfall on Sahyadri with relation of physical feature. The main objectives of the study are as follows:

i. To find out relationship of rainfall and physical feature.
ii. To investigate the spatio-temporal distribution of rainfall in Sahyadri.
iii. To demarcate trend of rainfall distribution.
iv. To check symmetry of rainfall pattern.
v. To critically compare the behavior of rainfall pattern over Sahyadri.
vi. To investigate the drought incident in Sahyadri.
vii. To study the monsoon reliability of the study area.

## 5. DATA COLLECTION

The data is important part of every research. Data is divided into two parts, i.e. Primary and Secondary data. This research is mainly depending on secondary data. The Secondary data will be collected from following sources:

a. National Climate Data Center, Indian Meteorology Department, Pune.
b. District Gazetteers.
c. Skymat Weather Services Pvt. Ltd, Vashi, Navi Mumbai.
d. Hydrology Project, Water Resources Department, Government of Maharashtra, Nasik.

## 6. RESEARCH METHODOLOGY

Research methodology is the main part in research. It helps for analyzing the vast data. For the analysis of rainfall data following method is used.

i. **Mean**- use for the average of monthly minimum and maximum rainfall.

$$\overline{x} = \frac{\Sigma x}{n}$$

Where, $\bar{X}$ = mean
$\Sigma x$= sum of x values,

n = number of values

ii. **Standard Deviation-** It will be used for the measurement of rainfall dispersion.

$$S = \sqrt{\frac{\Sigma(X-\bar{X})^2}{N}}$$

Where, S = the Standard deviation of a sample,
$\Sigma$ = means sum of $(X - \bar{X})^2$,
X = each value in the data set,
$\bar{X}$ = mean of all values in the data set,
N = number of values in the data set.

iii. **Rainfall Distribution**.

$$RFD = \frac{ARF}{MRF} \times 100$$

Where, RFD = rainfall distribution
ARF = actual rainfall
MRF = mean rainfall

iv. **Rainfall Intensity**

$$I = \frac{P}{N}$$

Where, I = rainfall intensity,
P = total amount of rainfall,
N = number of rain days.

v. **Wet Day**

$$WD = \frac{RD\ in\ X^{th}\ month}{122} \times 100$$

Where, WD = wet day
RD = rainy day

vi. **Coefficient of Variability-**

$$cv = \frac{S}{\bar{X}} \times 100$$

Where, cv = coefficient of variance
S = standard deviation,
$\overline{X}$ = mean annual rainfall.

vii. **Correlation coefficient**

$$r = \frac{n\,(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{(n\Sigma x^2 - (\Sigma x)^2)\,[n\Sigma y^2 - (\Sigma y)^2]}}$$

Where,

n = number of pairs of scores,
Σxy = sum of the products of paired scores,
Σx = sum of x scores,
Σy = sum of y scores,
$\Sigma x^2$ = sum of squared x scores,
$\Sigma y^2$ = sum of squared y scores.

viii. **Skewness-** It will be used to check symmetry of the rainfall distribution.

$$\pi_3 = \frac{\Sigma(x - \bar{x})^3}{N\sigma_3}$$

Where, $\pi_3$ = third moment of a variable x about the mean

$\sigma$ = standard deviation

ix. **Kurtosis-** It will be used for the analysis of peakedness of rainfall.

$$\pi_4 = \frac{(x - \bar{x})^4}{N\sigma_4}$$

Where, $\pi_4$= 4th moment of a variable about the mean

$\sigma$ = standard deviation

x. **Regression Analysis**

$$y' = a + bx$$

$$a = \frac{(\Sigma y)(\Sigma x^2) - (\Sigma x)(\Sigma xy)}{n(\Sigma x^2) - (\Sigma x)^2}$$

$$b = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{n(\Sigma x^2) - (\Sigma x)^2}$$

xi. **ANOM's –** use for the comparative analysis of rainfall.

xii. **Trend Analysis and Moving Average Methods.**

xiii. **Modified Drought Index**

$$MDI = SPI \times RD$$

Where, MDI= modified drought index

SPI = standard precipitation index

RD = number of rainy days

xiv. **Multivariate approach and Distribution free approach**- use to estimation of assured availability of rainfall.

xv. **Construction of Hydergarph.**

xvi. **Seasonality Index.**

xvii. **Standardized Precipitation Index (SPI) -** SPI will use to investigate intensity of drought.

xviii. **Software-**

The software is essential part of every research for the data analysis and data presentation. The following softwares will be used for this research: ArcGIS, Global Mapper, Google Earth, Minitab, Coral Draw, MS Office and SPSS. Rather than GPS receiver shall be used in research for getting the position of rainfall stations.

## 7. IMPORTANCE AND SCOPE OF RESEARCH

The Sahyadri is selected for research work. Following are the main reasons for the selection of given subject:

- This study is useful to demarcate monsoon variability on the Sahyadri.
- This study is useful to understanding the relationship between rainfall and physiography.
- The study is useful for define the onset and break of monsoon in Sahyadri.
- In previous some years, the district associated Sahyadri were facing the problem of drought condition, so study will investigate the trend of rainfall over the Sahyadri.
- The rainfall plays an important role in regional disparity of Sahyadri.

- The normal rainfall pattern changes from south to north in India but in Sahyadri it changes from west to east.
- The western parts of Sahyadri receive heavy rainfall. Whereas, eastern parts receive very low rainfall. It will be possible to divert westward flowing water towards the eastward of Sahyadri.

## 8. PROPOSED WORK PLAN

Proposed research works are divided into three years. As per plan the proposed work will be done as follows:

**First Year Plan-**

i. Review of published and unpublished literature.
ii. Collection of primary and secondary data related to the research area.

**Second Year Plan:**

i. Data editing and tabulation.
ii. Data analysis.
iii. Preparation of maps and diagrams.

**Third Year Plan:**

i. Data interpretation.
ii. Writing and preparation of thesis.
iii. Submission of thesis.

## 9. SCHEME OF CHAPTER

The research work entitled **"Spatio-Temporal Analysis of Rainfall Variability on Sahyadri in Maharashtra"** will be framed into seven chapters that are follows:

Chapter 1st **"Introduction"** will consist of introduction of Rainfall, Study area, Objectives of research, Data, Methodology, Scope, Importance and Limitation of study, Literature review and Scheme of chapter.

Chapter 2nd **"Physical Setting of Sahyadri"** In this chapter, Physical Setting of Sahyadri, including the location, physiography, climate, drainage, soils and natural vegetation etc. of Sahyadri will be studied.

Chapter 3rd **"Rainfall Pattern in Sahyadri"** associated with the Monsoon reliability, Rain gauge stations, Latitudinal, Longitudinal, altitudinal distribution of rainfall.

Chapter 4th **"Factors Affecting on Rainfall"** consists with the impacting factors on rainfall, i.e. Physiography, Vegetation, Temperature etc.

Chapter 5th **"Symmetry and Trend of Rainfall"** deals with trend and symmetry of rainfall.

Chapter 6th **"Drought Climatology of Sahyadri"** includes the analysis of various drought indices in the study region.

Chapter 7th "**Monsoon Reliability"** deals with the reliability of monsoon in the study area.

Chapter 8th **"Summary and Conclusion"** consists with the concluding remark and recommendation of research output.

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